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USDA-Forest Service	1. NUMBER SRS-4106	2. STATION Southern Research Station
RESEARCH WORK UNIT DESCRIPTION Ref. FSM 4070	**3. UNIT LOCATION** Monticello, Arkansas	

4. RESEARCH WORK UNIT TITLE
Management of Upland Forest Ecosystems of the Midsouth

5. PROJECT LEADER (name and address)
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6. AREA OF RESEARCH APPLICABILITY	7. ESTIMATED DURATION
Arkansas, Oklahoma, Texas, Louisiana, Mississippi, Alabama	5 years

8. MISSION
To develop and disseminate the scientific information necessary to realize the full range of benefits from the major upland forest types of the Midsouth—the mixed loblolly-shortleaf pine and pine-hardwood forests of the upper West Gulf Coastal Plain, the shortleaf pine and pine-hardwood forests of the Ouachita and Ozark Mountains, and the upland oak-hickory forests of the Ozark Mountains.

9. JUSTIFICATION AND PROBLEM SELECTION

This document outlines the future direction of forestry research conducted by Research Work Unit (RWU) SRS-4106 of the Southern Research Station, USDA Forest Service. The unit is located on the campus of the University of Arkansas at Monticello in association with the School of Forest Resources. The unit also maintains offices in Hot Springs AR, Crossett AR, Jessieville AR, and Jasper AR, and manages four Experimental Forests: the Crossett EF in Crossett AR, the Koen EF in Jasper AR, the Alum Creek EF in Jessieville AR, and the Sylamore EF in Mountain View AR.

The RWU contributes to two of the Southern Research Station's cross-cutting strategic science themes—Sustainability and Productivity of Southern Pine Ecosystems, and Sustainability and Productivity of the Interior Highlands Ecosystems.

The three problem areas identified in this document build on work from previous RWUDs and lay out a research program that addresses important ecological and management questions in the Midsouth at three spatial scales—the plant, the stand, and the landscape. This approach should provide the capability to understand and to manage the upland forests of the Midsouth to ensure their health, diversity, sustainability, and productivity. In doing so, these problem areas address key components of the SRS Strategic Plan and the agency's national initiatives. This approach provides a basis for development of quantitative tools as well as practical guidelines and advice for silvicultural practices associated with naturally-regenerated stands and landscapes dominated by such stands, within and across ownerships, and under varying levels and intensities of management.

The following sections present in more detail our view of a research approach that will lead to accomplishment of our mission. These sections represent a program consistent with our current staff capabilities, our budget and money available for cooperative agreements, and the investment we have in ongoing research.

Signature	Title	Date
Recommended:		
/s/ Nancy Herbert	Assistant Director-Mountains	8/27/03
/s/ VC Baldwin Jr	Assistant to Staff Director-VMPR	9/15/03
/s/ Douglas F. Ryan	Assistant to Staff Director-WFWAR	9/15/03
/s/ Jimmy L. Reaves	Staff Director-VMPR	9/15/03
/s/ James D. Sedell	Staff Director-WFWAR	9/15/03
Approved:		
/s/ Peter J. Roussopoulos	Station Director	10/6/03
Concurred		
/s/ Barbara C. Weber	Deputy Chief for Research	10/7/03

The historical emphasis of this research unit has been the development of silvicultural systems and reproduction cutting methods that rely upon natural regeneration. A large part of the clientele for this work has been non-industrial private forest landowners, who for various reasons may choose to employ low-cost forest management alternatives that rely on natural regeneration—the even-aged seed tree and shelterwood methods, and the uneven-aged group selection and single-tree selection methods.

More recently, land managers in the Forest Service have begun to use similar practices, because of the general disapproval with which the public holds the practice of clearcutting, and, to a lesser extent, the use of genetically-improved planting stock. Finally, these classical silvicultural alternatives have application on forest industry lands, especially in the often highly-productive lands along streams and other protected sites. Also applicable are certain instances where large high-quality products are desired.

Four other elements of the RWU mission merit special attention. First, the unit is the Station's repository of expertise in the theory and practice of uneven-aged silviculture in southern pines. This expertise dates back to the origins of the RWU in the 1930s, and continues in studies that are still in place. Unit scientists have continued to be productive in their efforts to better quantify the methodology for application of uneven-aged methods in the major forest types of the region. For example, the Project Leader has been called to provide expertise on how uneven-aged management might be implemented in forest types such as longleaf pine that extend beyond the forest types of traditional research interest.

The second element is the recent renewal of the RWU's focus on technology transfer of silvicultural research. This type of work was an integral part of the unit's historical mission; a number of old photographs in RWU archives show the unit's first project leader, Russ Reynolds, in deep conversation about forestry with 4-H club members. Expertise in technology transfer was a special talent of the unit's second project leader, Jim Baker, during the 1980s, and that work was honored by a 1990 USDA Award in Technology Transfer. Under the current Project Leader, two major commitments to technology transfer have been made—the reestablishment of the annual Crossett Forestry Field Day, and the hiring of the first professional forester at the Crossett EF since the 1960s with primary responsibility for unit technology transfer for clients in public, private, and industrial forestry.

Third, the unit has supported substantial efforts in hydrology through the staffing of a research hydrologist and support personnel as a result of the Station's reorganization in 1996. At that time, the personnel and studies that remained from the closure of the Station's Forest Hydrology Lab in Oxford, MS were transferred to this unit. The hydrology research that was retained by the unit has focused on National Forest System lands on the Ouachita and Ozark Mountains, but also includes a fruitful cooperative relationship with forest industry and academia in the region.

Finally, the RWU has been the keystone for support and development of the Ouachita Ecosystem Management Research project, an interdisciplinary study with stand-level and landscape-scale elements in separate study designs. This study has been developed and maintained through close cooperation with Region 8, with the Ouachita National Forest and the Ozark-St.Francis National Forest, and with Weyerhaeuser Company. Significant collaboration has been established with three other Forest Service research work units. Since the early 1990s, the unit has shared a portion of its operating funds with SRS-4251, Integrated Management of Wildlife Habitat and Timber Resources, at Nacogdoches TX; that unit has conducted a series of interrelated studies on the effects of forest management on wildlife species and habitat at the stand and landscape scale. Similarly, unit funding has been used to provide for cooperative research in aquatic ecology through SRS-4351, the Center for Bottomland Hardwoods. The recent epidemic outbreak of the native red oak borer in Arkansas and Missouri has strengthened and formalized the cooperative relationship between SRS-4106 and NC-4154, Ecology and Management of Central Hardwood Forests, in Columbia MO. These relationships will continue over the next five years as funding allows.

The research program described in this document is designed to develop a better understanding of naturally-regenerated forest stands, including providing information on regeneration biology, seed germination, seedling establishment, and the development of immature and mature stands. The research focus is at several

scales–the individual tree, the stand, and the forest as a whole. The emphasis is not just on the ecology of these various stages, but also on the ways that forest managers can intervene in the stand establishment and development processes to enhance forest productivity and sustainability. The unit has taken the broad view that forest productivity and sustainability encompasses the need to address issues of hydrology, aquatic ecology, non-woody vegetation, and social science, especially at larger landscape scales.

Regeneration is the fundamental indicator of forest sustainability at the stand level. Regeneration of desired tree species must occur in adequate numbers and acceptable distribution within a stand following partial or complete disturbance or harvest of the dominant overstory trees. The most critical period in stand development occurs when a landowner decides to harvest the dominant overstory. Outcomes include conversion to non-forest cover, inactive reforestation with whatever assemblage of vegetation emerges after harvest with no plans for regeneration, or planned silvicultural interventions of varying degree that result in naturally-regenerated or planted stands of desired species at acceptable densities and distribution. Forest managers and landowners who follow one of the last two strategies need to be able to predict the outcome of different regeneration decisions. This requires not only an understanding of regeneration ecology of desired woody plant species, as well as species such as herbaceous plants that compete with them. It also requires an understanding about how regeneration interacts with management prescriptions, such as the increased use of prescribed burning, in both naturally-regenerated and planted stands across the upland forests of the Midsouth. And, in those instances where fire might be impractical, we also need to understand what other silvicultural treatments can be used to emulate the ecological effects of fire for regeneration establishment and development. In short, **our understanding of the factors that govern the establishment and early development of natural regeneration of pines and hardwoods limits our ability to maintain the productivity and sustainability of forest stands in the Midsouth (Problem 1).**

The decisions that face landowners of upland forests in the Midsouth are not over when their forested stands have been regenerated. The application and timing of intermediate treatments in immature stands have a great deal to do with the length of time required to achieve ownership objectives and the quality of resource conditions and outputs that exist. Similarly, expected outcomes of management decisions in mature stands subject to reproduction cutting will vary from the possibilities associated with clearcutting and planting versus even-aged and uneven-aged neoclassical reproduction cutting methods, and even depend on the details of application within any one of those methods. **Our ability to apply and modify silvicultural practices in immature and mature stands of naturally-regenerated pines and hardwoods of the Midsouth is limited by our understanding of the ecological patterns and processes that govern stand dynamics and development (Problem 2).** As our understanding of the ecological dynamics in immature and mature stands of upland forest stands in the Midsouth increases, we will be better able to predict how these stands respond to management interventions. This information will enable forest managers to make wise choices among various silvicultural systems and practices to provide the desired mix of resources.

Land ownership in the southern United States is discontinuous and fragmented to varying degrees. Differences in ownership objectives lead to considerable variation in the frequency, intensity, and scale of management actions. Rarely do land managers have the luxury of embarking on a forest management program in a landscape over which the landowner has complete control. Rather, the management actions taken by a landowner must be made knowing that the actions of adjacent landowners may have an impact on the condition of all the lands in the landscape, and further, that decisions made by a landowner might depend to a certain degree on the actions of adjacent landowners. Large-scale ecosystem-based research offers the opportunity to evaluate the interactions among different parts of the system and by quantifying ecosystem capacity to produce benefits. These studies have significance both theoretically, and in specific application to the region. The linkage between stand-level treatments and landscape-level management is more than just the sum of their components. Landscape-level management starts with an array of alternatives, but each stand/treatment combination must be located in space and time so as to sustain and enhance landscape ecosystem attributes. Yet we have little information to apply to management decisions either in theory or in application to the landscapes commonly found in the Interior Highlands of Arkansas and Oklahoma**. Our ability to ensure the health, sustainability, and productivity of upland forests in the Midsouth is limited**

by our incomplete understanding of the cumulative hydrological and ecological effects that result when management activities are imposed across a landscape (Problem 3).

10. APPROACH TO PROBLEM SOLUTION

An overview of the three problems is presented here. However, the addition of several new scientists to the unit over the past five years, coupled with the continuation of the general direction in problem areas from the previous RWUD, creates a situation in which the current complement of scientists had little to do with the development of the problem areas largely inherited from the previous RWUD. In this situation, new problem analyses will be prepared by the unit scientists. This will meet three objectives--it will allow scientists to update the problem analyses with current available science; it will provide an opportunity for new scientists to work together and build unit cohesion, and it will enable the scientists to develop a sense of ownership of the problems within which they work.

Problem 1-- Our understanding of the factors that govern the establishment and early development of natural regeneration of pines and hardwoods limits our ability to maintain the productivity and sustainability of forest stands in the Midsouth.

Reproduction cutting methods that rely on natural regeneration of desired species provide a low-cost means for reforestation of harvested stands. However, successful application of natural regeneration techniques requires a basic understanding of the processes involved, which are complex and not as controllable as artificial regeneration techniques associated with plantation culture. Most natural reproduction cutting methods retain overstory trees that produce shade and compete with regeneration for light, moisture, and nutrients. Also, pines and hardwoods react differently to environmental conditions and have different strategies for regeneration. For example, most pine seedlings develop from seeds dispersed after the reproduction cut; whereas the hardwoods (especially the oaks) develop mainly from existing advance reproduction or from sprouts. Factors determining the density, stocking, and species composition of natural regeneration include seed supply, seedbed conditions, competing vegetation, and limiting resources. These are the factors that need additional investigation.

A better understanding of processes affecting natural regeneration also facilitates the development of integrated vegetation management techniques that recognize the importance of suppressing vegetation, but only to the extent that such vegetation interferes with beneficial plants or other land uses. Integrated vegetation management allows flexibility in using a variety of techniques, such as biological, fire, mechanical, and chemical treatments, to manipulate competing vegetation. Vegetation management programs must also be integrated with other cultural activities so that the whole gamut of forest benefits is considered. The unit will continue to refine its existing program of research in vegetation management.

The study of planting in application to neoclassical silvicultural systems has not been a focus of research in this RWU, largely because the RWU (SRS-4111) located in Pineville LA has research on plantation silviculture as part of its mission. The two RWUs consult with each other and often work cooperatively when research is needed regarding how and when to supplement natural regeneration with planting. Specific areas of research interest for SRS-4106 include situations where natural regeneration is marginal or inadequate, or when other attributes found in planted seedlings, such as resistance to certain diseases or different growth potential, might be desirable.

Accomplishments planned in the next five years include:

- An overview of oak regeneration in Boston Mountains of Arkansas;

- An overview of shortleaf pine regeneration establishment and development under different reproduction cutting methods in Arkansas and Oklahoma; and

- Comparison of effectiveness of various reproduction cutting methods for developing seedlings in Coastal Plain stands, using prescribed fire and herbicides for site preparation and release.

- Recovery of pines and hardwoods from simulated browsing and logging damage in Coastal Plain stands

- An overview of cone maturity and seed germination ecology in loblolly and shortleaf pines

Problem 2— Our ability to apply and modify silvicultural practices in immature and mature stands of naturally-regenerated pines and hardwoods of the Midsouth is limited by our understanding of the ecological patterns and processes that govern stand dynamics and development.

Research under this problem pertains to all the forest types within the RWU mission, and will concentrate in two broad areas—immature stands and mature stands. With respect to **immature stands**, research will emphasize stand developmental dynamics, and how those dynamics can be altered under the influence of generally-accepted intermediate treatments such as thinning, cull tree removal, stand improvement, and prescribed burning. Outcomes that are sought include quantifiable relationships that can be developed in both a practical management context and a process model capability for use by landowners or, more likely, the professional resource managers who advise landowners on their management questions.

Research in **mature stands** will concentrate on the end game of stand development, so as to quantify the effects of different reproduction cutting methods as they are applied to increasingly varied forest types. With this understanding, we will be able to develop and refine methods to meet increasingly diverse needs of landowners and land managers who wish to retain older trees through part or all of subsequent rotations or cutting cycles. Traditional neoclassical reproduction cutting methods have assumed, in an even-aged context that, shortly after the new stand is established, the old stand would be subject to final removal. In an uneven-aged context, similar assumptions have been made about the largest acceptable diameter beyond which a tree would be harvested regardless of its growth. The theory and practice of retaining a significant component of older trees through the extended development period of the succeeding cohort has not been clearly discussed in the silvicultural literature, and is a logical extension of this RWU's research.

Most of the silvicultural studies, especially the long-term demonstrations, maintained by the unit have emphasized traditional results in stand development or growth and yield. There is interest in broadening the silvicultural practices under study, such as prescribed fire, herbicides, and mechanical treatments. There is also interest in evaluating practices with a wider variety of metrics such as long-term economic and multi-resource evaluations. Both of these goals can be met through modification of existing studies or development of new studies that tier conceptually to existing ones. The need for vegetation management in any forest environment is usually based on subjective evaluations rather than quantitative assessments. There is a need to develop vegetation assessment techniques that will give quantitative credence to these evaluation efforts.

Accomplishments planned in the next five years include:

- An overview of ice damage in Coastal Plain pine stands;

- Synthesize information on stand development in shortleaf pine and pine-hardwood stands under different reproduction cutting methods and restoration prescriptions in the Interior Highlands;

- Provide a better understanding of the patterns and processes of old growth stand development, and silvicultural practices that can emulate old-growth characteristics;

- Adapt existing ecological process models to include stand development and growth and yield for naturally-regenerated stands of southern pines; and

- An overview of oak forest ecology and management in the Interior Highlands.

Problem 3— Our ability to ensure the health, sustainability, and productivity of upland forests in the Midsouth is limited by our incomplete understanding of the cumulative hydrological and ecological effects that result when management activities are imposed across a landscape.

The landscape-level "Ecosystem Management" research program that this unit established in the eastern Ouachita Mountains provides scientists with the opportunity to develop models and test them on experimentally monitored landscapes (large watersheds). This research program and the studies that are allied with it embrace a variety of resources of keen interest to landowners and resource managers—especially aquatic ecology, social science, resource economics, and vegetation.

The effect of landscape-scale actions on ecosystem hydrology is an area of key importance to this unit's research program. With our watershed-level experimental design, the unit hydrologist is able to assess the cumulative hydrological effects using field studies at installations nested across these large watersheds. Beyond hydrology, the RWU's emphasis in this problem area has been to establish a rather large "ground-truth" opportunity within which scientists and land managers can develop and validate existing simple models of land management applied more or less homogeneously over large areas, with emphasis on trends in vegetation and wildlife.

Research in this problem area includes a focus on water quality in the Interior Highlands. There is special interest in past research on small-catchment hydrology, but no one has yet attempted to integrate water quality and quantity within nested watersheds of increasing size. This unit has established studies to capture effects of management at larger scales, and concurrently to develop greater understanding of the hydrological behavior inherent in systems such as these in the Ouachita and Ozark Mountains that exhibit extremely rapid response to precipitation events .

Accomplishments planned in the next five years include:

- An overview of cumulative effects on terrestrial ecosystems as a result of management actions at the landscape scale;

- Determine the effects of forest roads and ATV trails on surface water and sediment generation, delivery, routing through, and impacts on Interior Highland watersheds;

- Quantify the pedological and water quality effects of shortleaf pine-bluestem grass ecosystem restoration practices; and

- Review the effects of disturbance processes and silvicultural systems in the short and long term on soils and water quality in the Interior Highlands.

Environmental considerations: Proposed research activities in Research Work Unit Description are expected to have little or no potential for soil movement, water quality degradation, or impact on sensitive resource values. The environmental effects of specific actions will be considered during the development of study plans, as well as the existence of extraordinary circumstances related to any proposed action, and categorical exclusion will be documented as a part of the study plan according to FSH 1909.15, Chapter 30. Where environmental concerns exist regarding particular studies, these may be evaluated within individual study plans, or by Environmental Assessments or Environmental Impact Statements prepared with and reviewed by the cooperating District or Forest staffs.

11. STAFFING and BUDGET

Since the last RWUD in 1996, SRS-4106 has experienced substantial change in scientist positions. The change in project leadership was necessitated by the medical disability and subsequent untimely passing of Paul Murphy, the previous Project Leader. In addition, three unit scientists retired since 1996--Baker, Graney, and Cain. Two new PFT scientists have been added, and a third scientist was transferred to the unit to cover the Station's upland hydrology program in the Interior Highlands. The unit currently has one vacant scientist position, and if budgets allow will actively recruit to fill this position.

The research described in this RWUD will require between 5 and 6 scientists per year, contingent upon unit budget. Unit budgets have been flat, and cost of living increases have continued to erode unit support. Between FY 2001 and FY 2003, the appropriation to the unit has been $1.768 million each year. The net to the RWU after Station overhead has declined by $25,000 to the FY 2003 level of $1.478 million. In addition, unit salary costs have risen by $42,000 to $1.017 million, with the vacant scientist position not included in that total. The unit has been able to accomplish a large program of work through additional funding from the national forests (KV monitoring dollars) and from the Southern Region (R8 technology transfer funds). We plan to increase the amount of extramural funding coming into the unit, otherwise it will be difficult to fill the vacant scientist position.

If appropriated funds are reduced, if SRS and WO overhead is increased, or if salary costs continue to rise, the simplest solution would be to not fill the vacant scientist position. Without this position, research accomplishments in Problems 1 and 2 would be reduced in years 2-5. Any increases in appropriated funds would be used to fill this vacant scientist position.

As KV funds run their course of five-year availability, reductions in expected products would be found in problems 2 and 3, and in the ability to support related wildlife research by SRS scientists and others associated with the Ouachita Ecosystem Management Research Project.

Distribution of SYs through the five-year term is approximately as follows:

Problem Area	Scientist years per year of the RWUD				
	1	2	3	4	5
1	0.5	0.75	1	1	1
2	2.5	2.75	3	3	3
3	2	2	2	2	2
Total	5	5.5	6	6	6

The scientific staff consists of six permanent full-time scientist positions. One serves concurrently as the Project Leader, four are filled by PFT appointments, and one is currently vacant. There are two professional forester positions (one PFT position at Crossett in support of the RWU technology transfer program, and one PFT position in Hot Springs in support of the project's ecosystem management research.), and one PFT professional hydrologist position (in Hot Springs, in support of the project's hydrology research) There are four PFT forestry technicians (two in Crossett to support Monticello scientists, and two in Jasper to support the upland hardwood research), and two term forestry technicians (one in Hot Springs, currently vacant, to support the ecosystem management research, and the other in Jasper to support the upland hardwood research.)

12. TECHNOLOGY TRANSFER

The technology transfer goal for the RWU is to serve as a primary source of information about silviculture of upland forest stands in the Midsouth for clients in public, private, and industrial forestry. A high degree of commitment to technology transfer has been maintained over time by the unit, typified by activities such as the ongoing series of annual Forestry Field Days, field tours for college classes, and training such as the unit's responsibility for the southern pine module of the Region 8 silviculture certification program. To assist in the management of our technology transfer program, the PL recently hired a professional forester at the Crossett Experimental Forest. Through this position, the unit will work closely with Region 8 to formalize technology transfer planning and execution. Our goal is to enhance the formal and informal training opportunities available to professionals and others interested in forest management of upland forests in the Midsouth through an integrated program of research, demonstration, and training.